in open or partially shaded situations from the sea-level to about 5,000 feet altitude. Dr. J. K. Small [Torreya 3: 141. 1903] reports it "from sea-level to almost 4,000 feet altitude on the eastern slopes of the Blue Ridge. * * * It is confined to trees only when rocks are lacking." Mr. C. L. Pollard [Plant World 5: 133. 1902] records a locality discovered by Mr. W. P. Hay, near the Potomac River and within fifteen miles of Washington, D. C.; this is possibly the most northern locality known for this fern. This little colony of plants, from which the figured specimen was taken, grows on a steep rocky slope; it consists of numerous plants matted together and covering many square feet of surface. In this respect it differs from another of the rock-loving ferns, *Cheilanthes lanosa*, which forms small clusters along the fissures of the rocks.

Our specimen is of interest also on account of its forking frond — a rare phenomenon in this species — which, may I state it, holds its own in beauty. *Cheilanthes lanosa* may possibly excel it as an ornament in its native haunts.

Washington, D. C.

THE ARTIFICIAL INDUCTION OF LEAF FORMATION IN THE OCOTILLO *

By Francis E. Lloyd

The post-pluvial appearance of foliage within a very short time upon desert plants which remain through periods of drought in a leafless condition is a phenomenon which has very often been remarked. The behavior in this regard is most striking in deserts, where there is prolonged lack of rain. Although in some regions the rain penetrates into the ground very rapidly, nevertheless it has seemed improbable to many, no doubt, that the absorption of this water from the soil alone gives the necessary stimulus to leaf formation. Led by this idea, attempts have been made to find in many of the superficial structures of plants the means for the absorption of water, or water vapor, and it may very well be

* This work was done at the Desert Botanical Laboratory, Tucson, Arizona, under a grant from the Carnegie Institution, of Washington, during the summer of 1905.

that experimental research will in the future throw light upon the extent of adaptation, as evidenced by anatomical structures, to which plants have attained in this matter. It was during a conversation upon such points with Dr. W. A. Cannon at the Desert Botanical Laboratory that the suggestion was made by him that it would be instructive to see if any light could be obtained upon the influence of meteoric water upon the development of leaves in *Fouquieria splendens*, the ocotillo of the southwest. I accordingly planned three experiments which were carried out upon a perfectly leafless plant, all alike in principle, but differing in details. In one case, the only one I shall describe, a reservoir, consisting of a gallon bottle, was attached to the neighboring limbs of a "palo verde," and a siphon arranged to lead water to a string of cheese-cloth, which in turn led the water to a bandage of the same cloth tied about a stem of the ocotillo three feet from the ground. The fierce winds several times played havoc with my arrangements, but finally I managed to adjust the apparatus to the swinging of the stems by allowing slack in the cheese-cloth string. The siphon ended in a capillary tube, so that the flow of water was small and, while it ran down the ocotillo stem at times, it did not reach the ground in any case. The reservoir was replenished daily, but the flow of water was discontinuous. The result was, of course, a closer simulation of the actual occurrences at the time of the rainy season.

The first run of water was applied on the morning of the first of July, and this was repeated each day. The stem was thus kept more or less wet for half the time. On the evening of the fourth, the leaves along 12–15 inches of the stem below the bandage showed marked development, being 1 centimeter long; and by the sixth of July, at three P. M., their length was 1.5 centimeters. On July 9, the largest leaves were 2 centimeters long, and the branch in question, together with its neighbors were photographed (Fig. 1). In looking at this picture one must realize that all the stems shown were at first equally leafless. It will be instructive to compare the above facts with those observed after rain.

On July 11, at 5 P. M., we had the first shower of the rainy season, the amount of precipitation being one and one-tenth inches within two hours, drenching, of course, all the vegetation. On the following day (the 12th) at four P. M., it was quite evident to the eye that the buds had made a start. By July 13, the slender conical buds along the whole extent of the stems were 7 to 8 millimeters long. On July 14 at five A. M., the rosettes of leaves were well formed; the length of the largest leaves was 1.5 centi-

FIG. 1. *Fouquieria splendens*, showing a branch which had been irrigated during four days.

meters, their size being, however, quite uniform. On July 15, the photograph forming the second figure was taken. It will be noted that the leaves on the irrigated stem were at that time much larger than the freshly formed leaves, that is, those produced after the rain, and as a result of the stimulus thereby given.

It will be noted that the development after the rain was more rapid than after irrigation, notwithstanding that the water was applied artifically from time to time during the period of growth under observation, while the wetting by rain occurred but once. The fact, however, must not be lost sight of, that following the rain there is a marked rise in the relative humidity, though I regret that I did not take observations on this point at the position of the plant. Then, too, the ground got a good soaking, and it is remarkable how rapidly the soil becomes moist for a considerable depth. Undoubtedly this fact was contributory to the rapid growth of the post-pluvial foliage. In the experiment detailed above, the total growth in a few days was due wholly to the water available on the surface of the stem, and the inference is not strained, I believe, if we conclude that, normally, the first stimulus to growth in the leaves is due to the water taken up, probably, at or near the buds. In view of the very thick coating of waxy

FIG. 2. *Fouquieria splendens* — the same as in FIG. 1, three days after a rain.

bark it seems unlikely that the water would find entrance elsewhere, though we may be wrong in this, since there are rifts through which conceivably the water might enter.

It may also be noted that the buds of the ocotillo are minute, sometimes indeed scarcely visible, and covered by, at most, a few light-brown, thin, chaffy scales. The repeated loss of leaves at the same place results in a rough area surrounding the base of the bud at which water may, we may well believe, be taken up. There is otherwise no evidence of the presence of any special adaptive structures to this end, and their absence in a very marked desert type of plant is not to be overlooked. That the absorption of water by the stem is of no very great importance, if any, in the economy of the ocotillo, may perhaps well be maintained; while on the other hand we might argue that in regions where the rain is very scarce the very rapid production of foliage would be of so great importance that even the little water absorbed would be equally so. At any rate, the question here barely touched upon is one of a host of similar ones which need elucidation by constant study under just such special conditions as are to be found in the desert.

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AN OLD SWAMP-BOTTOM

By Edward W. Berry

We all make our pilgrimage to the swamp: the lover of flowers for the pink lady's-slipper, giant rhododendron, fragrant pogonia and Indian tea-kettle (*Sarracenia*); the collector for these and for coptis, the sun-dew, and the ferns and sedges that haunt the inaccessible tangles of verdure which no swamp ever lacks. There are swamps and swamps, but all are of unfailing interest, whether the pilgrim be botanist, entomologist, or merely a seeker for cranberries or blueberries. They have equally their vernal and autumnal coloration. In the spring, the violet and marsh-marigold; in the fall, the closed gentian and bidens.

No swamp is of more interest than a fossil swamp, and it is my purpose to take you on a little journey to one such — not to one of those gigantic examples of buried marshes where in the far-off Carboniferous age was laid down the world's supply of coal, but to the remains of one of those smaller swamps that flourished during the Cretaceous and was like the many swamps that dot the country at the present time, where the mosquito and hyla flourish and the magnolia blooms.

Going back a few million years, three to five is a reasonable estimate, we come upon a time when deposition was active along